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DEVELOPMENT AND CHARACHTERIZATION OF BARLEY SUPLLEMENTED FLAVORED CHAPATTIS

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ABSTRACT
Food scientist are actively involved to improve the quality of wheat through composite flour technology by supplementing wheat flour with other grain flours. Barley grains are outstanding source of total dietary fibers (TDF) and offers remarkable quantity of active ingredients for health elevation and disease prevention. Purposely, the current research work was designed to improve the nutritional potential of wheat chapattis by including barley flour 10%, 20%, 30% along with the addition of functional blend (Methi powder and garlic paste) 2%, 4%, 6% levels respectively. Wheat and barley composite flour were analyzed for its chemical, mineral, antioxidant and total dietary composition. The supplementation of barley flour and functional blend into wheat flour enhanced the mineral. Addition of barley flour and functional blend increased total phenolic in composite flour 0.41 (control) to 0.69 mg GAE.100g^{-1} and DPPH from 20.95 – 23.82%. Total dietary fiber in composite flour varied form 3.11% (control) to 7.69% (30% barley flour with 6% functional blend). Total dietary fiber in chapattis ranged from 6.04 (control) to 8.21% (30% barley flour with 6% functional blend). 30% supplementation of barley flour and 4% addition of functional blend presented better sensory response of the prepared chapattis. All the outcomes revealed that nutritionally rich chapattis should be incorporated in daily diet to explore the dietary worth of barley.

Keywords: Composite flour technology; antioxidant; total dietary fiber; chapatti

INTRODUCTION
Cereals are known to have a positive influence on the general state of human body. Healthier diet can be provided by consuming cereal grains containing high fiber that are low in sugar content and high in fiber and fiber foods has been suggested to control over the health issues such as cardiovascular diseases, hypertension, colon cancer and diabetes **(Sudha et al., 2015)** Based on the recent state of the science, there is reasonable indication that risk of obesity can be minimized by taking a diet that is a combination of whole grains and bran or abundant in cereal fiber. The nutritional gains of whole grain foods are mainly credited due to the occurrence of bioactive compounds **(Edge et al., 2005)**.

Predominantly consumption of wheat is for the purpose of production of unleavened flat bread usually known as chapatti in Pakistan and entitled as primary cereal crop in the world **(Gujral and Pathak, 2002)**. Wheat grain is characterized by elevated amount of carbohydrate content (about 70%), comparatively low protein content (9 to 13%), low moisture content, little amounts of lipids, minerals, vitamins and fiber **(Dholakia, 2001)**.

Barley (*Hordeum vulgare* L.) is used as porridge by human beings, forage for cattles, in making fine superiority beers, alcoholic beverages and used in poultry feeds. Due to its various applications, barley has occupied vital position among cereals at global level **(Wahid, 2006)**. Barley provides number of health benefits and contains complex carbohydrate generally starch for the purposes to gain energy, adequate amount of protein that fulfill the requirement of amino acids, vitamins particularly vitamin E, low fat, total fiber, antioxidants mainly polyphenolics and minerals **(Frost et al., 2011)**. Nutritionally important at least fourteen mineral elements have been existed in fluctuating amounts in whole barley flour **(Jilal, 2011)**. Secondary metabolites present in barley grains are known as phenolic compounds. They are antioxidant provide protection against cardiovascular diseases and collectively these properties are called as biological properties **(Han, 2007)**.

The procedure of mingling whole wheat flour with other cereals and legumes flours to attain better nourishment, to impart functional characteristics, to reduce cost of production and to make the usage of locally available raw materials is known as composite flour technology **(Butt et**

al., 2011). **Hussein et al. (2011)** conducted a study as an effort to unravel the scarcity in wheat production by replacing a share of wheat flour (WF) with gelatinized corn flour (GCF), whole meal barley flour (WBF) and both of them in bread. It was found that the incorporation of gelatinized corn flour and whole meal barley into bread improved ash, protein, fiber, fat, β-glucan and minerals (P, K, Fe and Ca). Nutritional worth and protein percentage of wheat flour foodstuffs might be upgraded by using composite flours **(Ajithkumar et al., 2005)**. Fenugreek (Trigonella foenum-graecum) is well recognized for imparting flavor to several traditional foods. Besides, it provides tremendous amount of active ingredients for health promotion and disease prevention. Methi powder is added in chapatti as a taste adjusts for chapatti. Supplementation of fenugreek seed powder in bread serve as functional food accredited to rich nutritional, antioxidant and sensory quality **(Afzal et al., 2016)**. Addition of 5% methi powder enlarged the alimentary worth of flour principally in terms of higher intake of fibers and minerals e.g. iron and calcium **(Dhingra and Jood, 2004)**.

Chapatti prepared from composite flour can be included in the diet for the better management of diabetes and also beneficial to keep away from further secondary complications. To yield suitable chapattis corn, oat, sorghum and barley flour has also been assimilated in wheat flour **(Gujral and Pathak 2002)**. Addition of 15 – 20% barley flour in wheat flour was acceptable for bread preparation. Overall appearance, texture, and flavor was good but poor sensory characteristics like poor brown color, hard crumb texture and reduced loaf volume was observed due to increased level of barley flour **(Dhingra and Jood, 2004)**. **Lagasse et al. (2006)** also reported that better quality bread can be made from 15 – 30% barley flour with minor alteration in texture, shape and color. The color and appearance of chapattis were found to be suitable with the substitution of wheat flour by 30% of barley flour whereas flavor and texture were acceptable even at 40% substitution levels. So, the people requirements of chapattis which is staple food are fulfilled by making composite flours of other cereals and legumes.

Planned actions were required to improve the nutritional profile of people consuming wheat flour chapattis only. Massive population can be easily covered if we assume staple food as a source of supplementation **(Butt et al., 2007)**.

Scientific hypothesis

The recent research was conducted to assess the nutritional properties of composite flour prepared by adding barley flour and to select the best suitable flavored chapattis prepared with barley and functional blend.

MATERIAL AND METHODOLOGY

Procurement of raw material

The study was carried out at National Institute of Food Science and Technology, University of Agriculture, Faisalabad. Commercially available wheat variety named Galaxy 2013 and barley variety named B 9008 was procured from Wheat Research Institute, Ayub Agriculture Research Institute (AARI), Faisalabad. Chemicals were purchased from local market.

Sample Preparation

Wheat and barley grains was thoroughly cleaned to remove dirt, dust, insect, moldy seeds and foreign matter. The raw wheat sample and barely sample were milled to flour sample and stored in airtight container before use. To prepare functional blend fresh leaves of methi were washed and directly dried in the sun for 4 – 5 days. The dried leaves ground by grinder to make powder. For the preparation of garlic paste, garlic was washed and ground to make paste. Methi powder and garlic paste were mixed together in equal ratio to form functional blend.

Analysis of wheat and barley flour samples

The wheat and barley flour samples were analyzed for moisture, ash, crude fat, crude protein, crude fiber and nitrogen free extract according to their respective methods as described in **AACC (2000)**.

Preparation of composite flours

Wheat flour was blended with barley flour and functional blend in different combinations as mentioned in Table 1. Each treatment of composite flour was thoroughly mixed in order to achieve the uniform dispersion of barley flour in wheat flour.

Chemical analysis of composite flour

The wheat and barley composite flour samples were analyzed for moisture, ash, crude fat, crude protein, crude fiber and nitrogen free extract according to the respective methods as described in **AACC (2000)**.

Mineral contents

Sodium and potassium were measured through flame photometer (Sherwood Flame Photometer 410, Sherwood Scientific Ltd. Cambridge, UK), while calcium, magnesium, zinc, copper, iron and manganese measured by using Atomic Absorption Spectrophotometer (Varian AA 240, Victoria, Australia) by following the procedure of **AOAC (2006)**.

Determination of anti-oxidant profile

To determine the antioxidant profile of composite flour total phenolic content was determined by following methods.

Determination of Total phenolic content (TPC)

The total phenolic compounds in composite flour were estimated by Folin-Ciocalteu method (FCM) described by **Kahkonen et al. (1999)**.

Radical Scavenging Activity by using DPPH Method.

The antioxidant activity of composite flour was determined based on the radical scavenging ability in reacting with a stable DPPH free radical **(Afify et al., 2012)**.

Dietary fiber of composite flour

The flours were analyzed for total dietary fiber content according to method No. 32-05 as described in **(AACC, 2000)** by employing Megazyme Assay Kit. The samples were dispersed in a buffer solution and incubated with heat-stable α-amylase at 95 – 100°C for 35 minutes. After cooling the samples these were incubated at 60°C for 30 minutes by adding 100 µL protease solution. Furthermore, α-amylase and protease treated samples were incubated with amylo glucosidase at 60°C for 30 min. The fiber contents were precipitated by the addition of alcohol in 1 : 4 ratios and filtered. Residue was washed with alcohol and acetone. A blank was run in a similar manner. TDF was determined by applying formula.

Preparation of chapattis

Different blends along with 100% wheat flour control were used to make the chapattis. Dough was made by mixing samples with water for few minutes in a mixer and allowed to rest. The dough was then rolled up manually and turned into chapattis, the dough was be baked on hot plate **(Shahzadi, 2004)**.

Dietary fibers in chapattis

Dietary fiber content of chapattis prepared from the

Table 1 Treatment Plan for wheat-barley composite flours.

Treatments	Wheat flour %	Barley flour %	Functional ingredients blend %
T_0	100	-	-
T_1	88	10	2
T_2	78	20	2
T_3	68	30	2
T_4	86	10	4
T_5	76	20	4
T_6	66	30	4
T_7	84	10	6
T_8	74	20	6
T_9	64	30	6

Table 2 Chemical composition (%) of Wheat and barley flour.

Treatments	Moisture (%)	Ash (%)	Protein (%)	Fiber (%)	NFE
Wheat	9.08 ±0.18	1.38 ±0.04	11.54 ±0.24	1.33 ±0.05	76.26 ±0.37
Barley	7.14 ±0.46	3.05 ±0.24	13.63 ±0.14	3.51 ±0.18	72.14 ±0.10

Table 3 Chemical composition (%) of different supplemented flour.

Treatments	Moisture Content (%)	Ash (%)	Protein (%)	Crude Fat (%)	Fiber (%)	NFE (%)
T_0	9.03 ±0.44^{a}	1.38 ±0.04^{d}	11.54 ±0.24 ^{e}	1.74 ±0.04 ^{ab}	1.33 ±0.04^{h}	74.98 ±0.37^{a}
T_1	8.65 ±0.32^{ab}	1.50 ±0.01^{cd}	11.68 ±0.22^{de}	1.87 ±0.05 ^{ab}	1.51 ±0.07^{gh}	74.91 ±0.29 ^{ab}
T_2	8.17 ±0.25^{abc}	1.72 ±0.03^{bcd}	12.32 ±0.17^{bcd}	2.17 ±0.01^{ab}	1.85 ±0.02^{def}	74.11 ±0.50^{abcd}
T_3	7.60 ±0.36^{c}	1.98 ±0.01^{ab}	12.84 ±0.08^{ab}	2.26 ±0.07^{ab}	2.0 ±0.03^{abc}	73.70 ±0.45^{bcde}
T_4	8.71 ±0.44 ^{ab}	1.55 ±0.02^{cd}	11.74 ±0.10^{de}	1.88 ±0.01 ^{ab}	1.63 ±0.05^{fg}	74.68 ±0.36 ^{ab}
T_5	8.35 ±0.40^{abc}	1.79 ±0.01^{bc}	12.48 ±0.11^{abc}	2.13 ±0.03 ^{ab}	1.92 ±0.04^{cde}	73.69 ±0.39^{bcde}
T_6	7.82 ±0.39^{bc}	2.09 ±0.18^{ab}	12.99 ±0.37^{ab}	2.33 ±0.09^{a}	2.23 ±0.06^{ab}	73.10 ±0.61^{de}
T_7	8.83 ±0.33 ^{ab}	1.60 ±0.03^{cd}	11.79 ±0.33^{cde}	1.94 ±0.03 ^{ab}	1.75 ±0.07^{efg}	74.37 ±0.15^{abc}
T_8	8.51 ±0.30^{abc}	1.656 ±0.02^{bc}	12.57 ±0.41^{ab}	2.21 ±0.02 ^{ab}	1.95±0.01^{bcd}	73.31 ±0.60^{cde}
T_9	8.01 ±0.32^{abc}	1.792 ±0.02^{a}	13.1 ±0.084^{a}	2.37 ±0.62^{a}	2.54 ±0.03^{a}	72.57 ±0.25^{e}

Note: Values expressed are means ± standard deviation; T0: whole Wheat Flour (Control); T_1: 88% whole wheat flour +10% barley flour +2% Functional blend; T_2: 78% whole wheat flour +20% barley flour +2% Functional blend, T_3: 68% whole wheat flour +30% barley flour +2% Functional blend, T_4: 86% whole wheat flour +10% barley flour +4% Functional blend, T_5: 76% whole wheat flour +20% barley flour +4% Functional blend, T_6: 66% whole wheat flour +30% barley flour +4% Functional blend, T_7: 84% whole wheat flour +10% barley flour +6% Functional blend, T_8: 74% whole wheat flour +20% barley flour +6% Functional blend, T_9: 64% whole wheat flour +30% barley flour +6% Functional blend.

different treatments of composite flour was determined by following method described **(Prosky et al., 1987)**.

Sensory evaluation of chapattis

Sensory evaluation of chapattis was carried out for various sensory attributes like flavor, texture, color, taste, chewingability and foldingabiity by the panel of 5 trained judges from the National Institute of Food Science and Technology having expertise in Cereal Technology according to the 9-point hedonic scale as described according to the protocol of **Meilgard et al. (2006)**.

Statisic analysis

All analyses were carried out in triplicate and the data was reported as means ±standard deviation computed through Microsoft Excel 2013. Significant difference among treatments was evaluated through analysis of variance (ANOVA) under completely randomized design (CRD).

The results obtained from different parameters of all the treatments were exposed to statistical analysis. Completely Randomized Design (CRD) was used, followed by the Analysis of Variance Technique (ANOVA) and the results were interpreted according to the Least Significant Difference Test (LSD) at 5% level of significance as described by **(Steel et al., 1997)**.

RESULTS AND DISCUSSION

Characterization of wheat and barley flour

The means for proximate composition of both flours given in Table 2. Moisture, crude fat, total ash, crude protein, crude fiber and nitrogen free extract was 9.08, 1.74, 1.33, 11.54%, 76.26% in whole wheat flour and 7.08%, 13.63%, 4.04%, 3.11%, 3.05% and 72.14 in whole barley flour respectively. The whole barley flour possessed minimum moisture content and nitrogen free extract (NFE) as compared to wheat flour. Whole barley flour yielded higher contents of protein, fat, ash and crude fiber as compared to wheat flour sample.

The outcomes of current analysis are in accordance with **Yalmlahi and Ouhuuine (2013)**. whose result supports that moisture content in wheat flour is greater than

Table 4 Sodium and potassium, calcium, magnesium minerals composition of wheat and barley supplemented flours.

Treatments	Na (mg.100g^{-1})	K (mg.100g^{-1})	Ca (mg.100g^{-1})	Mg (mg.100g^{-1})
T_0	2.02 ±0.36^{e}	684.00 ±5.56^{d}	23.09 ±2.38	152.33 ±3.11^{f}
T_1	2.71 ±0.33^{e}	697.00 ±8.54^{cd}	24.68 ±0.94	158.33 ±3.05^{ef}
T_2	3.68 ±0.22^{cd}	712.67 ±5.50^{bc}	25.94 ±1.97	167.63 ±2.07^{bcde}
T_3	4.73 ±0.77^{ab}	728.00 ±3.00^{ab}	27.02 ±2.21	175.78 ±3.86^{ab}
T_4	2.81 ±0.25^{de}	685.80 ±5.30^{d}	24.74 ±1.14	159.77 ±2.92^{def}
T_5	3.70 ±0.14^{cd}	698.53 ±6.30^{cd}	26.04 ±2.74	168.67 ±4.72^{abcd}
T_6	4.77 ±0.17^{a}	729.88 ±2.80^{ab}	27.14 ±3.24	177.13 ±3.72^{ab}
T_7	2.88 ±0.20^{cde}	687.21 ±5.93^{d}	24.83 ±3.37	161.47 ±3.83^{cdef}
T_8	3.78 ±0.22^{bc}	700.07 ±10.8^{cd}	26.19 ±2.79	169.93 ±4.02^{abc}
T_9	4.79 ±0.11^{a}	731.77 ±10.76^{a}	27.21 ±2.9	178.67 ±2.66^{a}

Note: Values expressed are means ± standard deviation; T0: whole Wheat Flour (Control); T_1: 88% whole wheat flour +10% barley flour +2% Functional blend; T_2: 78% whole wheat flour +20% barley flour +2% Functional blend, $T_{3:}$ 68% whole wheat flour +30% barley flour +2% Functional blend, T_4: 86% whole wheat flour +10% barley flour +4% Functional blend, T_5: 76% whole wheat flour +20% barley flour +4% Functional blend, T_6: 66% whole wheat flour +30% barley flour +4% Functional blend, T_7: 84% whole wheat flour +10% barley flour +6% Functional blend, T_8: 74% whole wheat flour +20% barley flour +6% Functional blend, T_9: 64% whole wheat flour +30% barley flour +6% Functional blend.

Table 5 Manganese, iron, copper and zinc composition of wheat and barley supplemented flours.

Treatments	Mn (mg.100g^{-1})	Fe (mg.100g^{-1})	Cu (mg.100g^{-1})	Zn (mg.100g^{-1})
T_0	3.80 ±0.19^{d}	1.71 ±0.48^{c}	0.31 ±0.01^{f}	2.90 ±0.38^{c}
T_1	3.95 ±0.15^{cd}	2.47 ±0.49^{bc}	0.34 ±0.02^{ef}	3.64 ±0.21^{bc}
T_2	4.37 ±0.28^{bcd}	3.83 ±1.16^{ab}	0.39 ±0.04^{cde}	4.74 ±0.41^{ab}
T_3	4.97 ±0.29^{ab}	4.76 ±0.49^{a}	0.46 ±0.07^{abc}	5.32 ±0.38^{a}
T_4	3.99 ±0.19^{cd}	2.49 ±0.34^{bc}	0.35 ±0.03^{def}	3.67 ±0.08^{bc}
T_5	4.40 ±0.14^{bcd}	3.88 ±0.31^{ab}	0.41 ±0.06^{bcd}	4.76 ±0.05^{ab}
T_6	5.00 ±0.20^{ab}	4.78 ±0.46^{a}	0.47 ±0.1^{ab}	5.36 ±0.28^{a}
T_7	4.24 ±0.24^{cd}	2.54 ±0.31^{bc}	0.36 ±0.08^{def}	3.70 ±0.25^{bc}
T_8	4.46 ±0.19^{bc}	3.90 ±0.26^{ab}	0.43 ±0.05^{abc}	4.81 ±0.43^{ab}
T_9	5.18 ±0.33^{a}	4.83 ±0.42^{a}	0.49 ±0.02^{a}	5.42 ±0.56^{a}

Note: Values expressed are means ± standard deviation; T0: whole Wheat Flour (Control); T1: 88% whole wheat flour +10% barley flour +2% Functional blend; T2: 78% whole wheat flour +20% barley flour +2% Functional blend, T3: 68% whole wheat flour +30% barley flour +2% Functional blend, T4: 86% whole wheat flour +10% barley flour +4% Functional blend, T5: 76% whole wheat flour +20% barley flour +4% Functional blend, T6: 66% whole wheat flour +30% barley flour +4% Functional blend, T7: 84% whole wheat flour +10% barley flour +6% Functional blend, T8: 74% whole wheat flour +20% barley flour +6% Functional blend, T9: 64% whole wheat flour +30% barley flour +6% Functional blend.

Table 6 Total dietary fiber composition of wheat and barley supplemented flour and chapattis.

Treatments	TDF in flour (%)	TDF in chapattis (%)
T_0	3.11 ±0.10^d	6.04 ±0.075^f
T_1	5.81 ±0.06^c	7.34 ±0.046^e
T_2	6.52 ±0.28^b	7.76 ±0.040^d
T_3	7.47 ±0.06^a	7.98 ±0.074^{bc}
T_4	5.89 ±0.04^c	7.42 ±0.046^e
T_5	6.63 ±0.06^b	7.81 ±0.050^{cd}
T_6	7.58 ±0.05^a	8.08 ±0.09^{ab}
T_7	5.95 ±0.08^c	7.49 ±0.06^e
T_8	6.71 ±0.16^b	7.87 ±0.078^{cd}
T_9	7.69 ±0.05^a	8.21 ±0.095^a

Note: Values expressed are means ± standard deviation; TDF: Total dietary fiber, T0: whole Wheat Flour (Control); T_1: 88% whole wheat flour +10% barley flour +2% Functional blend; T_2: 78% whole wheat flour +20% barley flour +2% Functional blend, T_3: 68% whole wheat flour +30% barley flour +2% Functional blend, T_4: 86% whole wheat flour +10% barley flour +4% Functional blend, T_5: 76% whole wheat flour +20% barley flour +4% Functional blend, T_6: 66% whole wheat flour +30% barley flour +4% Functional blend, T_7: 84% whole wheat flour +10% barley flour +6% Functional blend, T_8: 74% whole wheat flour +20% barley flour +6% Functional blend, T_9: 64% whole wheat flour +30% barley flour +6% Functional blend.

Table 7 Antioxidants in different supplemented flours**.**

Treatments	TPC (mg GAE.g^{-1})	DPPH (%)
T_0	0.41±0.08^d	20.95 ±0.82^c
T_1	0.50 ±0.02^c	21.85 ±0.77^{bc}
T_2	0.60 ±0.03^b	22.79 ±0.04^{ab}
T_3	0.67 ±0.04^a	23.74 ±0.05^a
T_4	0.52 ±0.05^c	21.88 ±0.03^{bc}
T_5	0.61 ±0.07^b	22.82 ±0.26^{ab}
T_6	0.68 ±0.02^a	23.77 ±0.06^a
T_7	0.53 ±0.09^c	21.93 ±0.13^{bc}
T_8	0.62 ±0.04^b	22.87 ±0.05^{ab}
T_9	0.69 ±0.06^a	23.82 ±0.07^a

Note: Values expressed are means ± standard deviation; TPC: Total phenolic content, GAE: Gallic acid equivalents (Folin-Ciocalteu method), DPPH: 2,2-diphenyl-1-picrylhydrazyl, T_0: whole Wheat Flour (Control); T_1: 88% whole wheat flour +10% barley flour +2% Functional blend; T_2: 78% whole wheat flour +20% barley flour +2% Functional blend, T_3: 68% whole wheat flour +30% barley flour +2% Functional blend, T_4: 86% whole wheat flour +10% barley flour +4% Functional blend, T_5: 76% whole wheat flour +20% barley flour +4% Functional blend, T_6: 66% whole wheat flour +30% barley flour +4% Functional blend, T_7: 84% whole wheat flour +10% barley flour +6% Functional blend, T_8: 74% whole wheat flour +20% barley flour +6% Functional blend, T_9: 64% whole wheat flour +30% barley flour +6% Functional blend.

moisture content of barley flour. Moisture content was influenced by milling techniques. **Khan (2009)** revealed the same results for fat in whole wheat flour. In another research analysis **Hussein et al. (2013)** observed 4% fat in whole barley flour. As for barley flour, the value obtained is judged too high. This is due to the fact that the separation of germ from bran is not so fine during the barley milling as compared to wheat grain milling. The consequence of existing study are in close agreement with previous research work of **Hussein et al. (2013)**. They found 1.47% ash in wheat flour and 3.08% ash in barley flour. **Ejaz (2014)** noticed less protein content in wheat flour and higher in composite flour. **Ragaee et al. (2006)** made similar observation for protein content present in wheat flour. The results showed the higher percentage of crude fiber in whole barley flour as compare to the whole wheat flour. The results of present study regarding the fiber composition of whole wheat flour and whole barley flour are in close agreement with earlier research work of **Elzamzamy (2014)**. **Hussein et al. (2013)** observed the 1.65% of crude fiber in wheat flour and 3.35% crud fiber in whole barley flour. These results are in close agreement with present research analysis. **Khan (2009)** made similar observation for NFE in whole wheat flour. **Elzamzamy (2014)** made observation that NFE for whole wheat flour was greater than whole barley flour.

Analysis of Composite flour

Chemical composition of composite flours

The mean values regarding proximate composition of varying treatments have been revealed in table 3. The proximate composition of composite varied due to the varying amount of barley flour and functional blend supplemented into the wheat flour.

The highest moisture content (9.03%) was found in T_0 and minimum moisture content (7.6%) was noted in T_3 (68% whole wheat flour +30% barley flour +2% Functional blend). The current conclusions of existing research work are in agreement with **Yalmlahi and Ouhuuine (2013)**. Moisture content reduced by increasing the amount of barley flour moisture and this was attributed due to a greater water holding capacity of wheat flour than the barley flour.

Minimum ash content was found in control i.e. wheat flour while maximum in treatment T_9. **Shahzadi (2004)** observed the same outcomes in her. It was due to the fact because barley flour usually contains visible specks of bran and subsequently appears darker and is higher in ash content than wheat flour.

The mean value (Table 3) revealed that protein content in composite flour was ranged from 11.54 to 13.1%. Least protein content was observed in wheat flour and maximum in composite flour with 30% barley flour and 6% functional blend. **Beswa (2010)** found similar protein content in wheat-millet composite flour 10, 20 and 30% substitution levels. The present results are close enough to **Ejaz (2014)**. **Ragaee et al. (2006)** found higher protein content in barley and less protein content in hard and soft wheat. They explained the reason of higher protein content in barley. It was due to the reason because high nitrogen fertilization, in most instances, increases storage proteins (that are higher in barley that wheat) and thus total protein of barley.

The fat content varied from 1.74 to 2.37%. The significant increase in the fat content of composite flour with increasing levels of barley flour substitution may be explained by the fact that, the higher content of fat in whole grain product is due to the presence germ in which oil is concentrated and germ portion of barley grain is higher than wheat grain. Fat contents in wheat, sorghum, millet, rye and barley flour are observed by **Ragaee et al. (2006)** whose results are much closer with the discoveries of current outcomes. **Khan (2009)** and **Arab et al. (2010)** revealed same results for fat content in whole wheat flour and composite flours.

The fiber content varied from 2.54% to 1.33%. The significant (p <0.05) increase in the fibre content was due the reason that, wheat flour had lower fibre content values compared to barley flour. Barley contains higher amount of cellulose and lignins and both of these are mainly consisted in crude fiber and fiber portions are mainly

Table 8 Effect of various treatment on color, texture, folding ability and Chew ability of wheat and barley supplemented flavored chapattis.

Treatments	Color	Texture	Folding ability	Chew ability
T_0	7.41 ±0.050^{d}	8.02 ±0.074^{a}	7.91 ±0.04^{d}	8.53 ±0.04^{a}
T_1	6.46 ±0.042^{f}	7.53 ±0.047^{b}	7.27 ±0.08^{f}	5.51 ±0.23^{f}
T_2	8.01 ±0.061^{c}	6.13 ±0.096^{c}	8.32 ±0.05^{c}	6.52 ±0.13^{d}
T_3	8.75 ±0.129^{a}	4.79 ±0.031^{d}	8.68 ±0.07^{ab}	7.59 ±0.040^{b}
T_4	7.03 ±0.036^{e}	7.04 ±0.046^{e}	7.64 ±0.06^{e}	6.05 ±0.08^{e}
T_5	8.51 ±0.064^{b}	5.72 ±0.057^{f}	8.51 ±0.04^{bc}	7.15 ±0.04^{c}
T_6	8.85 ±0.08^{a}	4.54 ±0.04^{g}	8.79 ±0.05^{a}	8.25 ±0.05^{a}
T_7	5.14 ±0.06^{i}	6.52 ±0.05^{h}	6.04 ±0.06^{i}	5.31 ±0.06^{f}
T_8	5.60±0.061 ^{h}	5.31 ±0.050^{i}	6.36 ±0.05^{h}	4.58 ±0.02^{g}
T_9	6.05 ±0.012^{g}	4.147 ±0.06^{j}	6.76 ±0.1^{g}	4.13 ±0.07^{h}

Note: Values expressed are means ± standard deviation; T0: whole Wheat Flour (Control); T_1: 88% whole wheat flour +10% barley flour +2% Functional blend; T_2: 78% whole wheat flour +20% barley flour +2% Functional blend, T_3: 68% whole wheat flour +30% barley flour +2% Functional blend, T_4: 86% whole wheat flour +10% barley flour +4% Functional blend, T_5: 76% whole wheat flour +20% barley flour +4% Functional blend, T_6: 66% whole wheat flour +30% barley flour +4% Functional blend, T_7: 84% whole wheat flour +10% barley flour +6% Functional blend, T_8: 74% whole wheat flour +20% barley flour +6% Functional blend, T_9: 64% whole wheat flour +30% barley flour +6% Functional blend.

Table 9 Mean scores for the effect of various treatment on taste, breakability and overall acceptability of wheat and barley supplemented flavored chapattis.

Treatments	Taste	Breakability	Overall acceptability
T_0	6.98 ±0.06^{d}	5.31 ±0.06^{g}	7.02 ±0.17^{d}
T_1	5.94 ±0.04^{f}	4.75 ±0.1^{h}	6.05 ±0.06^{f}
T_2	7.45 ±0.07^{c}	6.70 ±0.06^{d}	7.56 ±0.08^{c}
T_3	8.47 ±0.03^{a}	7.71 ±0.070^{b}	8.50 ±0.09^{a}
T_4	6.48 ±0.23^{e}	4.43 ±0.08^{i}	6.58 ±0.16^{e}
T_5	7.95 ±0.10^{b}	7.10 ±0.05^{c}	8.01 ±0.20^{b}
T_6	8.7 ±0.22^{a}	8.21 ±0.04^{a}	8.90 ±0.25^{a}
T_7	4.58 ±0.13^{i}	4.03 ±0.08^{j}	4.54 ±0.13^{i}
T_8	5.03 ±0.09^{h}	6.30 ±0.06^{e}	5.09 ±0.10^{h}
T_9	4.57 ±0.03^{g}	5.80 ±0.07^{f}	5.53 ±0.05^{g}

Note: Values expressed are means ± standard deviation; T_0: whole Wheat Flour (Control); T_1: 88% whole wheat flour +10% barley flour +2% Functional blend; T_2: 78% whole wheat flour +20% barley flour +2% Functional blend, T_3: 68% whole wheat flour +30% barley flour +2% Functional blend, T_4: 86% whole wheat flour +10% barley flour +4% Functional blend, T_5: 76% whole wheat flour +20% barley flour +4% Functional blend, T_6: 66% whole wheat flour +30% barley flour +4% Functional blend, T_7: 84% whole wheat flour +10% barley flour +6% Functional blend, T_8: 74% whole wheat flour +20% barley flour +6% Functional blend, T_9: 64% whole wheat flour +30% barley flour 6% Functional blend.

concentrated in bran portion that are higher in barley flour due to poor sepration of bran during milling. Results of **Huma (2004)** are found to be similar to the analysis of current research results. The results are alike to the conclusions of previous researchers **(Butt et al., 2011; Sharma et al., 2011)**. They found greater percentage of crude fiber in composite flour as compared to the crude fiber content in wheat flour. This is due to the higher portion of bran in barley that contain higher content of fiber. Due to this reason crude fiber in barley increased the fiber content of wheat and barley composite flour.

NFE in composite flour was ranged from 72.57 to 74.98. As Nitrogen free extract is generally determined by subtracting sum of moister, protein, fat and fiber from 100. Maximum value was observed in whole wheat flour because it has lower value of protein, fat and fiber content as compared to the other treatments. While maximum value was found in T_3. It is due to the reason of having maximum percentage of barley flour and minimum percentage of functional blend among all treatment. **Khan (2009)** observed 74.64% NFE in whole wheat flour. Similarly, the consequences of existing work are sustained greatly by the judgements by **Ejaz (2014)** who reported decreasing trend for nitrogen free extract with the addition of barley and oatmeal flour.

Mineral composition

The mean value regarding macro and micro nutrients have been expressed in Table 4. The mean values for sodium content was described in table 4. The significant increase in sodium, potassium, magnesium, iron, copper, zinc, managanese content of composite flour with increasing levels of barley flour and functional blend was observed while calcium content did not differ significantly.

The judgements of **Arab et al. (2010)** are related to the consequences of existing research analysis who reported comparable results for sodium content in wheat flour. The potassium content was ranged from 570 $mg.100g^{-1}$ to 976.19 $mg.100g^{-1}$. According to the recent analysis, potassium content in whole wheat flour are found to be closer enough to research analysis of **Niazi (2015)** and **Ejaz (2014)**. The highest calcium content (27.21 $mg.100g^{-1}$) was found in T_9 while minimum value (23.09%) was observed in T_0. The effects of existing results of recent research are in accordance with the outcomes of **Hussein et al. (2013)** who reported similar results for calcium content in wheat flour. The results showed that as the supplementation of barley flour and functional blend increased, magnesium content also increased. The results of present study are in accordance with the findings of **Ejaz et al. (2014)** who reported similar magnesium content in whole wheat flour and similar increase in mineral content in composite flour (wheat flour supplemented with oat and barley flour). Highest managanese content (5.18 mg/100g) was found in T_9 while minimum value (3.8 $mg.100g^{-1}$) was observed in T_0. The findings of **Khan (2009)** are in agreement with the consequences of present research analysis. Khan observed the effect of soy supplementation on manganese content ($mg.100g^{-1}$) of composite flours. The variation in iron content is evident with an increase in the supplementation rate of barley flour, garlic paste and methi leaves. Highest iron content (4.83 $mg.100g^{-1}$) was found in T_9 while minimum value (1.71 $mg.100g^{-1}$) was observed in whole wheat flour. The outcomes of current study are in agreement with the conclusions of **Arab et al. (2010)** who described similar iron content in whole wheat flour. **Hussein et al. (2013)** observed the mineral content of whole barley flour (WBF) and wheat flour (WF) and found closer results. The copper content in composite flour was ranged from 0.31 $mg.100g^{-1}$ to 0.49 $mg.100g^{-1}$.

Copper content was improved by increasing the supplementation rate of barley flour and functional blend (methi leaves and garlic paste). The analysis of current work have interpreted same results that are strongly supported by work of **Hussein et al. (2013)**. Zinc content in composite flour was ranged from 2.9 $mg.100g^{-1}$ to 5.42 $mg.100g^{-1}$. The results of present study are in accordance with the findings of **Khan (2009)** who reported that zinc content ($mg.100g^{-1}$) increased by increasing the supplementation of soy composite flour.

The difference in mineral composition was may be attributed to more mineral content in whole barley flour as compared to the wheat flour in which bran portion in removed more easily during milling and minerals or ash are mainly concentrated in bran portion. While barley kernel are more hard and it is difficult to separate the bran portion.

Dietary fiber composition

Mean values for total dietary fiber of different composite flour and chapattis are presented in table 6. Total dietary fiber content of composite flour was ranged from 3.1% to 7.7% and it was ranged from 6.04% to 8.21% in composite flour chapattis. The result showed that maximum total dietary fiber content was found in treatment which contain highest amount of barley flour (30%) and highest percentage of functional blend (6%) while lowest in wheat flour.

Ragaee et al. (2006) reported the higher composition of total dietary fiber in barley than sorghum, rye and millet as compared to the wheat flour. The results of **Butt et al. (2011)** were closely related to the findings of present study who observed higher percentage of total dietary fiber in composite flour chapattis as compared to control. They observed that chapattis supplemented with 5% chickpea and 1% guar gum (CP5% +GG1%), 3% guar gum (GG 3%) and 2% guar gum (GG 2%) have higher composition of dietary fiber. Results regarding total dietary fiber content in composite flour and chapattis are in line with work of **Ejaz (2014)** who observed the total dietary fiber composition of barley and oatmeal supplemented chapattis.

Dietary fiber are not hydrolyzed in GI track because of absence of particular enzyme but partially hydrolyzed by microflora in the large intestine and produce short chain fatty acids. These short chain fatty acids prevent the cholesterol synthesis so help to reduce heart diseases and this is the main reason of using barley to reduce several heart diseases. The reason that why wheat flour chapattis had relatively low content of total dietary fiber is due to easy removal of bran or the outer kernel layers form wheat grain during milling and dietary fiber are mainly concentrated in bran portion.

Antioxidant analysis

The data related to mean values for total phenolic content and DPPH of composite flour are shown in Table 7. The result showed that higher total phenolic content (0.69 mg $GAE.g^{-1}$) was found in T_9 while minimum value (0.41 mg $GAE.g^{-1}$) was observed in T_0. Antioxidant properties of wheat and composite flours were evaluated on the basis of measuring scavenging activity for DPPH radicals. DPPH of composite flour was ranged from 20.95% to 23.82%. The outcomes of current research work are supported by the judgements of **Elzamzamy (2005)**. **Afzal et al. (2016)** designed the research work to elucidate nutritional and antioxidant potential of fenugreek seeds. **Sharma (2012)** reported antioxidant activity (17 – 24%) in barley flour that is higher than wheat flour. It ratifies that addition of barley flour and functional blend in whole wheat flour enhanced the total phenolic content.

The analysis specifies that rich basis of antioxidants are cereals especially barley. Before consumption, cereals are treated with different processing like milling, heat extraction, cooking, parboiling or other technique and most researcher found that processing of barley grains does not remove biologically important compounds and provide protection against free radical that attack on DNA, lipids and protein and thought to be an initiating factor for several chronic diseases **(Slavin et al. 2001)**. **Verardo et al. (2010)** used the barley that help to diminish the oxidation of lipid in bakery foodstuffs. They used barley as a source of phenolic compounds. So, decrease in peroxide value and increase in antioxidant activity is evident with the increase in supplementation rate of barley flour.

The score for acceptability of chapattis of different treatments ranged from 4.54 to 8.9. The highest acceptability (8.9) was found in chapattis prepared from T6 (66% whole wheat flour +30% barley flour +4% Functional blend) due to best color, finest taste, good foldingabiity and breakability, followed by T_3 , T_5, T_2, T_0, T_4, T_1 and lowest score (4.54) was found in chapattis prepared from T_7. T_6 acquired highest score in overall acceptability while nutritionally in all other parameters exceprt sensory T_9 scored best. In the present research, composite flour samples affected the overall acceptability due the variation in sensory attributes of barley flour, methi leaves and garlic paste. The outcomes of recent analysis are compatible with the judgements of **Ejaz (2014)**. **Shahzadi (2004)** also established similar overall acceptability score for wheat-chickpea composite flour.

CONCLUSION

Whole wheat flour supplemented with whole barley flour is a vital source of fibrous food. To improve the nutritional status of many food products, there is a requirement to explore the hidden sources of dietary fiber. In conclusion, barley flour can be a good option to obtain the nutritional significance and health expansions of wheat-based products because scheme that is dependent on diet is an exact approach as it is cost-effective and measureable to escape from health hazards. By incorporating barley flour into popularly consumed wheat-based products such as chapattis it could help consumers to improve their health. As wheat products become healthier by incorporating barley flour, it is expected to see continued and sustainable growth in barley consumption. So it is concluded that for the reason of having high fiber and dietary fiber content, more antioxidants and improved minerals profile as compared to the wheat flour, barley is considered as a desired food ingredient. Thus, intake of chapattis made by selected quantity of composite flours offers an additional health gains that would be helpful for normal humans to avoid diseases.

REFERENCES

AACC, 2000. Approved Methods of American Association of Cereal Chemists. American Association of Cereal Chemists, MN, USA : MN, USA.

Afify, A. M. R., El-Beltagi, H. S., EL-Salam, S. M. A., Omran, A. A. 2012. Biochemical changes in phenols, flavonoids, tannins, vitamin E, β-carotene and antioxidant activity during soaking of three white sorghum varieties. *Journal of Tropical Biomedicine*, vol. 2, no. 3, p. 203-209. https://doi.org/10.1016/S2221-1691(12)60042-2

Afzal, B., Pasha, I., Zahoor, T., Nawaz, H. 2016. Nutritional potential of fenugreek supplemented bread with special reference to antioxidant profiling. *Pakistan Journal of Agriculture Science*, vol. 53, p. 217-223. https://doi.org/10.21162/PAKJAS/16.4664

Ajithkumar, A., Anderson, R., Aman, P. 2005. Content and molecular behaviour of extractable -glucan in American and Swedish oat samples. *Journal of Agriculture of Food Chemistry*, vol. 53, no. 4, p. 1205-1209. https://doi.org/10.1021/jf040322c PMid:15713042

AOAC. 2006. Official Methods of Analysis of Association of Official Analytical Chemists International. 18th ed. Arlington, VA, USA : AOAC Press.

Arab, E. A. A., Helmy, I. M. F., Bareh, G. F. 2010. Nutritional evaluation and functional properties of chickpea (*Cicer arietinum* L.) flour and the improvement of spaghetti produced from its. *Journal ofAmerican Science*, vol. 6, no. 10, p. 1055-1072.

Beswa, D. 2008. *Assessment of the feasibility of using a wheat-Finger millet composite flour for bread making* : dissertation theses. South Africa : University of Johannesburg.

Butt, M. S., Shahzadi, N., Suleria, H. A. R., Sultan, T., Chohan, M. I. 2011. Effect of dietary fiber in lowering serum glucose and body weight in sprague dawley rats. *Functional Foods in Health Disease*, vol. 8, no. 2011, p. 261-278.

Dhingra, S., Jood, S. 2004. Effect of flour blending on functional, baking and organoleptic characteristics of bread. *International Journal of food Science Technology*, vol. 39, no. 2, p. 213-222. https://doi.org/10.1046/j.0950-5423.2003.00766.x

Dholakia, B. B. 2001. *Molecular approaches to decipher quantitative traits governing grain quality in hweats* : dissertation theses. India : University Pune.

Edge, M., Jones J. M., Marquart. L. 2005. A new life for whole grians. *Journal of the American Diet Association*, vol. 105, no. 12, p. 1856-1860. https://doi.org/10.1016/j.jada.2005.10.022 PMid:16321586

Ejaz, R. 2014. *Preparation of barley and oatmeal supplemented chapaties and its impact on serum biochemical profile in normal individuals* : M.Sc. Thesis. Faisalabad, Pakistan : University of Agriculture.

Elzamzamy, F. M. 2014. Chemical, Sensory and Microbiological Evaluation of Novel two Products Manufactured from Germinated Barley and Wheat Grains.

British Journal of Applied Science and Technology, vol. 4 no. 14, p. 2100-2113. https://doi.org/10.9734/BJAST/2014/4439

Frost, D. J., Adhikari, K., Lewis D. S. 2011. Effect of barley flour on physical and sensory characteristics of chocolate chip cookies. *Journal of food science and Technology*, vol. 48, no. 5, p. 569-576. https://doi.org/10.1007/s13197-010-0179-x PMid:23572789

Gujral, H. S., Pathak, A. 2002. Effect of composite flours and additives on the texture of chapati. *Journal of Food Engineering*, vol. 55, no. 2, p. 173-179. https://doi.org/10.1016/S0260-8774(02)00061-4

Hussein, A. M. S., Abd El-Azeem, A. S., Hegazy, A. M., Afifi, A. A., Gamal, H. R. 2011. Physiochemical, Sensory and Nutritional Properties of corn-fenugreek Flour composite biscuits. *Austutrilian Journal of Basic and Applied Science*, vol. 5, no. 4, p. 84-95.

Hussein, A. M. S., Kamil, M. M., Hegazy, N. A., Abo El-Nor, S. A. H. 2013. Effect of Wheat Flour Supplemented with Barely and/or Corn Flour on Balady Bread Quality. *Polish Journal of Food Nutrition*, vol. 63, no. 1, p. 11-18. https://doi.org/10.2478/v10222-012-0064-6

Jilal, A. 2011. *Assessment of genticaly diverse international barley germplasm for development of food product applications* : dissertation theses. Lismore, NSW : Southern Cross University.

Han, X., Shen, T., Lou, H. 2007. Dietary Polyphenols and Their Biological Significance. *International Journal of Molecule Science*, vol. 8, no. 9, p. 950-988. https://doi.org/10.3390/i8090950

Huma, N. 2004. *Fortification of whole flour with iron flour the production of unleavened flat bread (Chapattis)* : dissertation theses. Faisalabad, Pakistan : National Institute of Food Science and Technology, University of Agriculture.

Kahkonen, M. P., A. I. Hopia, H. J. Vuorela, J. P. Rauha, Khan, M. I. 2009. *Utilization of soy bean as a functional food.* Dissertation theses. Faisalabad, Pakistan : University of Agriculture.

Lagasse, S. L., Hatcher, D. W., Dexter, J. E., Rossnagel, B. G., Izydorczyk, M. S. 2006. Quality characteristics of fres and dried white salted noodles enriched with flours from hull-less barley genotypes of diverse amylose content. *Cereal Chemistry*, vol. 83, no. 2, p. 202-210. https://doi.org/10.1094/CC-83-0202

Meilgard, M. M., Civille, G. V., Carr, T. 2007. *Sensory evaluation techniques*. 4th ed. New York, NY, USA : CRC Press. 600 p. ISBN 9781482216905.

Niazi, S. 2015. M.Sc. Thesis. Faisalabad, Pakistan : University of Agriculture.

Pihlaja, K., Kujala, T. S., Heinonen, M. 1999. Antioxidant activity of plant extracts containing phenolic compounds. *Journal of Agriculture and Food Chemistry*, vol. 47, no. 10, p. 3954-3962. https://doi.org/10.1021/jf990146l PMid:10552749

Prosky, L., Asp, N.G., Schweizer, T., Devries, J. Furda, I. 1987. Determination of insoluble, soluble, and total dietary fiber in foods and food products: interlaboratory study. *Journal of Association of Analls Chemistry*, vol. 71, no. 5, p. 1017-1023.

Ragaee, S., Abdel-Aal, E. S. M., Noaman, M. 2006. Antioxidant activity and nutrient composition of selected cereals for food use. *Food Chemistry*, vol. 98, no. 1, p. 32-38. https://doi.org/10.1016/j.foodchem.2005.04.039

Shahzadi, N. 2004. *Use of composite flour for chapatti preparation in relation to serum profile* : dissertation theses. Faisalabad, Pakistan : University of Agriculture.

Shahzadi, N. 2004. *Use of composite flours for chapati preparation in relation to serum profile* : dissertation theses. Faisalabad, Pakistan : University of Agriculture.

Slavin, J. L., Jacobs, D., Marquart, L. 2001. Grain processing and nutrition. *Critical Reviews in Biotechnology*, vol. 21, p. 49-66. https://doi.org/10.1080/20013891081683 PMid:11307845

Sharma, P., Gujral, H. S. 2011. Effect of sand roasting and microwave cooking on antioxidant activity of barley. *Food Research International*, vol. 44, no. 1, p. 235-240. https://doi.org/10.1016/j.foodres.2010.10.030

Sharma, P., Gujral, H. S., Singh, B. 2012. Antioxidant activity of barley as affected by extrusion cooking. *Food Chemistry*, vol. 131, no. 4, p. 1406-1413. https://doi.org/10.1016/j.foodchem.2011.10.009

Sudha, M. L., Eipson, S. W., Hafeeza, K., Naidu, M. M., Rao, G. V. 2015. Effect of normal/dehydrated greens on the rheological, microstructural, nutritional and quality characteristics of paratha-an Indian flat bread. *Journal of Food Science and Technology*, vol. 52, no. 2, p. 1-9. https://doi.org/10.1007/s13197-013-1062-3 PMid:25694692

Verardo V., Ylenia, R., Trivisonno, M. C., Marconi, E., Caboni, M. F. 2010. Effect of the addition of air-classiffed barley flours on the lipid stability of bakery products. *European Food Research Technology*, vol. 231, no. 2, p.309-319. https://doi.org/10.1007/s00217-010-1288-5

Yamlahi, A. E., Ouhssine, M. 2013. Utilization of barley (*Hordeum vulgare* L.) flour with common wheat (*Triticum aestivum* L.) flour in bread-making. *Annual of Biological Research*, vol.4, p. 119-129.

Wahid, A. 2006. Productivity losses in barley attributable to ambient atmospheric pollutants in Pakistan. *Atmosphere Environment*, vol. 40, no. 28, p. 5342-5354. https://doi.org/10.1016/j.atmosenv.2006.04.050

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